CROWLEY MARINE SERVICES, INC.

March 19, 1996

Dr. David Kendall
Dredged Material Management Office
U.S. Army Corps of Engineers, Seattle District
P.O. Box 3755
Seattle, Washington 98124-2255

Subject: Submittal of PSDDA Data Report
Crowley Marine Services' 8th Avenue Terminal, Slip No. 4, Duwamish River, Seattle
Dredging Permit Application File No. 95-2-00537

Dear Dr. Kendall:

Enclosed is a data report submitted in support of Crowley's dredging permit application (File No. 95-2-00537) for evaluation of the sediments from Slip No. 4 for disposal at a Puget Sound Dredged Disposal Analysis (PSDDA) Program site. Based on past discussions with you, it is our understanding that only the sediments from dredged material management unit (DMMU) 2 are likely to be acceptable for such disposal. Crowley is currently exploring other options for the disposal of sediments from DMMUs 1, 3, and 4. Dredging is now scheduled for next fall or winter.

Please call me at 443-8042 or Dr. Lawrence McCrone of PTI Environmental Services at 643-9803 if you have any questions or wish to discuss these issues further.

Sincerely,

Stephen Wilson
Manager, Environmental Compliance

Enclosure

cc: Slip No.4 Corespondence w/o enclosure
Tuan Vu w/enclosure
Brad Marten w/o enclosure

CROW96-001

PTI
ENVIRONMENTAL SERVICES
15375 SE 30th Place, Suite 250 • Bellevue, Washington 98007

Data Report

Proposed Dredging of Slip No. 4, Duwamish River, Seattle, Washington

Submitted to

Puget Sound Dredged Disposal Analysis Program

PTI Contract C483-08-02

March 1996

KCSlip4 59971

SEA426270

CONTENTS

TECHNICAL MEMORANDUM: RESULTS OF PSDDA TESTING OF SLIP NO. 4 SEDIMENTS

INTRODUCTION

This technical memorandum summarizes the results of testing of sediments collected from Slip No. 4 on the Duwamish River in Seattle, Washington. This testing was conducted by PTI Environmental Services (PTI) on behalf of Crowley Marine Services (Crowley) in order to determine the suitability of these sediments for disposal at a Puget Sound Dredged Disposal Analysis (PSDDA) site. The proposed dredging of Slip No. 4, as well as the overall approach to this investigation, were described in the *PSDDA Sediment Characterization Sampling and Analysis Plan* (PTI 1995). For the purposes of evaluation of the sediments under the PSDDA program, the sediments proposed for dredging were divided into four dredged material management units (DMMUs). In July, 1995, two sediment cores were collected from each DMMU and the sediments within those two cores were composited as described by PTI (1995). The four composite sediment samples (i.e., one from each DMMU) were then chemically analyzed and subjected to three sediment toxicity tests, as described by PTI (1995). In addition, reference sediments were collected from Carr Inlet for use in the sediment toxicity tests. The reference sediments were analyzed for various conventional sediment variables, but were not analyzed for chemical contaminants.

RESULTS OF TESTING THE SEDIMENTS FROM THE FOUR DMMUS

Sediment Chemistry

The results of the chemical analyses of the four composite sediment samples from Slip No. 4 and of the reference sediment sample from Carr Inlet are reported in Table 1. The concentrations of chemicals for which there are PSDDA criteria are compared to those criteria in Table 1. The applicable criteria include screening levels (SLs), bioaccumulation trigger values (BTs), and maximum levels (MLs). Exceedances of the PSDDA SLs are indicated by a box around the concentration value. Exceedances of the PSDDA BTs are indicated by shading of the concentration value. Exceedances of the PSDDA MLs are indicated by both shading and a box around the concentration value. All four composite sediment samples exceeded various SLs, while only two exceeded BTs (DMMU1 for fluoranthene and DMMU4 for total polychlorinated biphenyls [PCBs]). Only one ML was exceeded in any of the four composite sediment samples (fluoranthene in DMMU1). On the basis of sediment chemistry alone, none of the four DMMUs should be precluded from disposal at a PSDDA site, although further bioaccumulation testing would be required to determine the suitability for such disposal of those sediments exceeding the PSDDA BTs.

Sediment Toxicity Tests

The results of the amphipod, echinoderm embryo, and *Neanthes* toxicity tests are summarized in Tables 2, 3, 4, and 5. Results are included for all four DMMUs, as well as for the Carr Inlet reference sediment. Also included are results for negative controls (i.e., Yaquina Bay control sediment in the case of the amphipod and *Neanthes* toxicity tests, and a seawater control in the case of the echinoderm embryo toxicity test). The results of these toxicity tests are then compared with PSDDA evaluation guidelines in Table 6. Included are the PSDDA performance standards for the negative control samples, the PSDDA performance standards for the reference area sediment, and the nondispersive disposal site interpretation guidelines. The nondispersive site interpretation guidelines include both the so-called "1-hit" and "2-hit" rules. Exceedance of either the "1-hit" or "2-hit" rules requires that: 1) the magnitude of the toxic response in the test sediment exceeds a given value (expressed relative to the response in either the negative control or the reference sediment), and 2) the toxic response in the test sediment must be statistically significantly different from the response in the reference sediment. Exceedance of the "1-hit" criterion by a single toxicity test for a given DMMU is sufficient to preclude disposal of the sediment from that DMMU at a PSDDA site. Exceedance of the "2-hit" criterion by one of the toxicity tests for a given DMMU would only preclude disposal of the sediment from that DMMU at a PSDDA site if that result was corroborated by the exceedance of a "2-hit" criterion by one of the other two toxicity tests.

All three toxicity tests satisfied all applicable performance standards for the negative controls and for the reference sediment. This implies acceptable performance was achieved in these tests for comparisons with the sediments from the four DMMUs. Statistical comparisons of each test sediment response with the corresponding response in the reference sediment were performed using an approximate *t*-test (i.e., assuming unequal variances). Differences were assessed using a one-tailed significance level (α) of 0.05 for the amphipod and *Neanthes* toxicity tests, and of 0.10 for the echinoderm embryo toxicity test.

For the amphipod toxicity test, the magnitudes of the toxic responses in the sediments from all four DMMUs were sufficient to exceed the "2-hit" criterion, but only the results for DMMU2, DMMU3, and DMMU4 were statistically different from the response for the reference sediment. The magnitudes of the toxic responses in the sediments from DMMU3 and DMMU4 were also sufficient to exceed the "1-hit" criterion. Therefore, on the basis of the amphipod toxicity test results alone, the sediments from DMMU3 and DMMU4 would be precluded from disposal at a PSDDA site. The sediments from DMMU2 would only be precluded from such disposal if the results for one of the other two toxicity tests also exceeded a "2-hit" criterion.

For the echinoderm embryo toxicity test, the magnitudes of the toxic responses in the sediments from DMMU1 and DMMU2 were sufficient to exceed the "2-hit" criterion, but neither result was statistically different from the response for the reference sediment. The toxic response in the sediment from DMMU3 was significantly different from (but lower than) the response for the reference sediment. The toxic responses in the sediments from DMMU4 were neither statistically distinguishable from the response in the reference sediment nor of sufficient magnitude to exceed either the "2-hit" or "1-hit" criteria. Therefore, on the basis of the echinoderm embryo toxicity test results (either alone or in conjunction with the results for either of the other two toxicity tests), there would be no reason to preclude disposal of the sediments from any of the four DMMUs at a PSDDA site.

For the *Neanthes* toxicity test, none of the toxic responses (either mortality or reductions in growth) in the sediments from any of the four DMMUs were statistically different from the response in the reference sediment. In addition, none were of sufficient magnitude to exceed either the "2-hit" or "1-hit" criteria. Therefore, on the basis of the *Neanthes* toxicity test results (either alone or in conjunction with the results for either of the other two toxicity tests), there would be no reason to preclude disposal of the sediments from any of the four DMMUs at a PSDDA site.

In conclusion, on the basis of sediment chemistry alone, none of the four DMMUs should be precluded from disposal at a PSDDA site, although further bioaccumulation testing would be required to determine the suitability for such disposal of those sediments exceeding the PSDDA BTs (DMMU1 and DMMU4). The only results of the sediment toxicity tests that would preclude disposal of the sediments at a PSDDA site are the amphipod toxicity test results for DMMU3 and DMMU4. Amphipod toxicity in the sediments from those two DMMUs was sufficiently great to exceed the "1-hit" criterion. Although the amphipod toxicity test results for DMMU2 exceeded the "2-hit" criterion, they were not corroborated by the results for either of the other two toxicity tests. Because the sediments from DMMU4 would be precluded from disposal at a PSDDA site as a result of the amphipod toxicity, there would be no point in conducting bioaccumulation bioassays of those sediments, that would otherwise have been necessitated by exceedance of the BT for total PCBs. For DMMU1, further assessment of the sediments through the conduct of bioaccumulation bioassays would be required because of the exceedance of the BT for fluoranthene. Sediments from DMMU2 should be suitable for disposal at a PSDDA site without further testing requirements.

BIOACCUMULATION BIOASSAY FOR DMMU1

To assess the bioaccumulation potential of the sediments from DMMU1 for evaluation of their suitability for disposal at a PSDDA site, it was necessary to recollect sediments from DMMU1, as described in a letter sampling and analysis plan, submitted to the Dredged Material Management Office of the U.S. Army Corps of Engineers on October 19, 1995. Subsequent revisions to that plan were described in a letter to the Dredged Material Management Office dated October 23, 1995. Sediment cores were again collected from Stations 1 and 2 within DMMU1, using a laser surveying system to reposition the sampling device as accurately as possible at the locations of the previous cores at those two stations. The sediments from the two stations were composited, as described in the plan, and submitted to the laboratories for analysis. In addition, reference sediments for use in the bioaccumulation bioassays were again collected from Carr Inlet, composited, and forwarded to the laboratories.

Both the sediments from DMMU1 and the reference sediments from Carr Inlet were analyzed for a number of conventional sediment variables. Only the sediments from DMMU1 were required to be analyzed for polycyclic aromatic hydrocarbons (PAHs). The results of these analyses are reported in Table 7. Despite every effort to relocate the sediment cores at the locations of the previously collected sediment cores from DMMU1, the concentrations of the PAHs were markedly lower (compare Table 1 with Table 7). Nevertheless, it was necessary to use these sediments in the bioaccumulation bioassays.

The bioaccumulation bioassays were conducted by the Battelle laboratory in Sequim, Washington, following the procedures described in the aforementioned October 19 and 23, 1995 letters. The test organisms were clams (*Macoma nasuta*) and polychaetes (*Nephtys caecoides*). Battelle was responsible for the collection of negative control sediments from Sequim Bay. The tissue samples were chemically analyzed by Columbia Analytical Services in Kelso, Washington.

The concentrations of PAHs were analyzed in five composite samples of the tissues of a subsample of the organisms of each species collected for use in these bioaccumulation bioassays (Table 8). These samples were referred to as "time 0" samples because they are presumed to be representative of the tissues of the organisms at the initiation of the laboratory exposures. Only two PAHs, fluoranthene and benzo(a)pyrene, were detected in the *Macoma* time 0 tissue samples, and both were just above the detection limits. None of the PAHs were detected in the *Nephtys* time 0 tissue samples.

At the conclusion of the 28-day exposures to reference and DMMU1 sediments, the organisms were allowed to depurate for 24 hours, and then five composite tissue samples were analyzed for each species from each sediment type (Table 8). Only two PAHs, chrysene and benzo(a)pyrene, were detected in the *Macoma* tissue samples from the reference sediment exposures, and both were just above the detection limits. None of the PAHs were detected in the *Nephtys* tissue samples from the reference sediment exposures. In contrast, a number of individual PAHs were detected in both the *Macoma* and *Nephtys* tissue samples from the DMMU1 sediment exposures, at concentrations in some cases substantially above the detection limits. Although no statistical analyses were performed because of the absence of detected concentrations in the reference sediment tissue samples, it is clear that the PAH concentrations in the DMMU1 tissue samples are significantly above those in the reference sediment tissue samples. While no objective criterion has been established within the PSDDA program for evaluating the acceptability of certain levels of bioaccumulation, indications are that the PSDDA agencies will use a rule-of-thumb currently applied by U.S. EPA Region 9 in similar circumstances. That rule-of-thumb is that a factor of 10-fold higher chemical concentrations in the tissues of organisms exposed to test sediment relative to those exposed to reference sediments will be considered unacceptable. Assuming that this rule-of-thumb will be applied by the PSDDA agencies on a best professional judgment basis, it appears likely that the sediments from DMMU1 will be considered unsuitable for disposal at a PSDDA site because they present an unacceptable risk for bioaccumulation of potentially toxic chemicals.

Tissue concentrations of chemical contaminants may be reported on either a wet-weight basis (as in Table 8) or a dry-weight basis. Unfortunately, there was insufficient tissue sample available in all replicate composite samples to perform the total solids analysis for conversion of the wet-weight concentrations to dry-weight concentrations. Total solids values are reported for 12 tissue samples in Table 9. Included are all replicate samples for *Macoma* in the DMMU1 and reference sediments at the conclusion of the laboratory exposures, and two of the replicate samples for *Nephtys* in the reference sediment at the conclusion of the laboratory exposures. There was relatively little variability in the total solids content in any of these samples. For those replicate samples with available total solids measurements, the actual values for each replicate were used in converting the wet-weight concentrations to dry-weight concentrations (Table 10). For those replicate samples without actual total solids values, the mean of the other total solids contents for each species was used instead. Given the relatively low level of variability in these values, the effect of using the mean total solids values rather than actual values on the resulting dry-weight concentrations would be minor. The dry-weight tissue concentrations of PAHs are presented only for completeness; the conclusions discussed above with regard to the bioaccumulation potential of these sediments would not be changed.

CONCLUSION

Comparison of the sediment chemical concentrations to the PSDDA SLs and MLs suggests that none of the four DMMUs should be precluded from disposal at a PSDDA site on the basis of sediment chemistry alone, although further bioaccumulation testing would be required to determine the suitability for such disposal of those sediments exceeding the PSDDA BTs (DMMU1 and DMMU4). Comparison of the toxicity test results to the PSDDA evaluation guidelines suggests that the sediments from DMMU3 and DMMU4 would be unsuitable for disposal at a PSDDA site on the basis of the amphipod toxicity tests. Under the rule-of-thumb evaluation criteria applied by the PSDDA agencies, it is likely that the agencies will consider the bioaccumulation potential of the sediments from DMMU1 to preclude those sediments from disposal at a PSDDA site. Based on sediment chemistry and toxicity test results, sediments from DMMU2 are likely to be found suitable for disposal at a PSDDA site. The sediments from DMMU1, DMMU3, and DMMU4 will likely need to be disposed of in an alternative manner.

REFERENCE

PTI. 1995. PSDDA sediment characterization sampling and analysis plan, Crowley's 8th Avenue Terminal Facility, Seattle, Washington. Prepared for Crowley Marine Services, Seattle, Washington. PTI Environmental Services, Bellevue, Washington.

TABLE 1. COMPARISON OF THE CHEMICAL RESULTS FOR THE 1995 COMPOSITE SEDIMENT SAMPLES TO PSDDA SCREENING LEVELS, BIOACCUMULATION TRIGGERS, AND MAXIMUM LEVELS

Chemical	Station(s): / Sample number:	DMMU1 1/2 CMS4-5	DMMU2 3/4 CMS4-1	DMMU3 5/6 CMS4-2	DMMU4 7/8 CMS4-3	Carr Inlet Reference CMS4-4	PSDDA SL	PSDDA BT	PSDDA ML
Conventional Variables									
Total volatile solids (%)		4.9 [a]	3.81	4	1.7	1.7	--	--	--
Total organic carbon (%)		2 [a]	2.4	2.7	2.3	0.56	--	--	--
Percent Gravel		3.54 [b]	6.46	2.7	0.81	0.35	--	--	--
Percent Sand		44.1 [b]	60.5	59.9	85.1	57.3	--	--	--
Percent Silt		39.9 [b]	24.1	26.8	11	36.6	--	--	--
Percent Clay		10.9 [b]	8.3	9.1	2.3	4.2	--	--	--
Total solids (%) [c]		73.8	72	69.4	73.3	66.8	--	--	--
Sulfides (mg/kg)		910 J [a]	1,100 J	93 J	2.6 J	15 J	--	--	--
Ammonia-nitrogen (mg/kg)		24 J [a]	7.7 J	38 J	17 J	22 J	--	--	--
Metals (mg/kg dry weight)									
Antimony		3.5 [a]	2 U	2 U	2 U		20	146	200
Arsenic		15.5 [a]	12	11	4		57	507.1	700
Cadmium		1.4 [a]	0.7	0.5	0.3 U		0.96	--	9.6
Copper		94 [a]	64	62	29		81	--	810
Lead		132 [a]	63.6	55.6	13.4		66	--	660
Total mercury		0.13 [a]	0.11	0.1	0.02 U		0.21	1.5	2.1
Nickel		42 [a]	28	30	25		140	1,022	--
Silver		0.4 [a]	0.4	0.6	0.2 U		1.2	4.6	6.1
Zinc		279 [a]	157	160	89		160	--	1,600
Semivolatile Organic Compounds (µg/kg dry weight) [d]									
Polycyclic aromatic hydrocarbons									
Total LPAH [e]		4,550	431	145	638		610	--	6,100
Naphthalene		30	22	20 U	25		210	--	2,100
Acenaphthylene		20 U	20 U	20 U	20 U		64	--	640
Acenaphthene		200	28	20 U	42		63	--	630
Fluorene		220	27	20 U	51		64	--	640
Phenanthrene		3,000	260	98	400		320	--	3,200
Anthracene		1,100	94	47	120		130	--	1,300
2-Methylnaphthalene		20 U	20 U	20 U	20 U		67	--	670
Total HPAH [f]		31,500	4,940	2,010	3,070		1,800	--	51,000
Fluoranthene		8,500	800	320	660		630	4,600	6,300
Pyrene		6,200	1,000	420	630		430	--	7,300
Benz[a]anthracene		3,600	480	160	270		450	--	4,500
Chrysene		4,000	560	220	340		670	--	6,700
Total benzofluoranthenes [g]		4,500	960	410	550		800	--	8,000
Benz[a]pyrene		2,300	520	200	260		680	4,964	6,800
Indeno[1,2,3-cd]pyrene		960	260	120	150		69	--	5,200
Dibenz[a,h]anthracene		450	84	31	52		120	--	1,200
Benzo[ghi]perylene		960	280	130	160		540	--	5,400
Chlorinated benzenes									
1,3-Dichlorobenzene		1.2 U	1.1 U	1.2 U	1.2 U		170	1,241	--
1,4-Dichlorobenzene		1.2 U	1.1 U	1.2 U	1.2 U		26	190	260
1,2-Dichlorobenzene		1.2 U	1.1 U	1.2 U	1.2 U		19	37	350
1,2,4-Trichlorobenzene		6 U	5.6 U	5.9 U	5.8 U		13	--	64
Hexachlorobenzene		20 U	20 U	20 U	20 U		23	168	230
Phthalate Esters									
Dimethyl phthalate		20 U	20 U	20 U	20 U		160	1,168	--
Diethyl phthalate		20 U	20 U	30	20 U		97	--	--
Di-n-butyl phthalate		20 U	20 U	20 U	20 U		1,400	10,220	--
Butylbenzyl phthalate		20 U	20 U	20 U	20 U		470	--	--
Bis[2-ethylhexyl]phthalate		76	210	300	290		3,100	13,870	--
Di-n-octyl phthalate		20 U	20 U	20 U	20 U		6,200	--	--
Phenols									
Phenol		20 U	21	20 U	20 U		120	--	1,200
2-Methylphenol		20 U	20 U	20 U	20 U		20	--	72
4-Methylphenol		20 U	20 U	20 U	20 U		120	--	1,200
2,4-Dimethylphenol		20 U	20 U	20 U	20 U		29	--	50
Pentachlorophenol		100 UJ	100 UJ	100 UJ	100 UJ		100	--	690
Miscellaneous Oxygenated Compounds									
Benzyl alcohol		20 U	20 U	20 U	20 U		25	--	73
Benzoic acid		200 U	200 U	200 U	200 U		400	--	690
Dibenzofuran		69	20 U	20 U	25		54	--	540

TABLE 1. (cont.)

Chemical	Station(s): / Sample number:	DMMU1 1/2 CMS4-5	DMMU2 3/4 CMS4-1	DMMU3 5/6 CMS4-2	DMMU4 7/8 CMS4-3	Carr Inlet Reference CMS4-4	PSDDA SL	PSDDA BT	PSDDA ML
Chlorinated Aliphatic Hydrocarbons									
Hexachloroethane		20 U	20 U	20 U	20 U		1,400	10,220	14,000
Hexachlorobutadiene		20 U	20 U	20 U	20 U		29	212	290
Organonitrogen Compounds									
N-nitrosodiphenylamine		20 U	20 U	20 U	20 U		28	161	220
Pesticides (μg/kg dry weight)									
4,4'-DDD		2 U	2 U	2 U	2 U		--	--	--
4,4'-DDE		2 U	2 U	2 U	2 U		--	--	--
4,4'-DDT		2 U	3.8 U	2.7 U	4.2 U		--	--	--
Total DDT[h]		2 U	3.8 U	2.7 U	4.2 U		6.9	50	69
Heptachlor		1 U	1 U	1 U	1 U		10	37	--
Chlordane		1 U	1 U	1 U	1 U		10	37	--
Aldrin		2.8 UJ	7.5 J	7.7 UJ	12 UJ		10	37	--
Dieldrin		2 U	2 U	2 U	2 U		10	37	--
Lindane		1 U	1 U	1 U	1 U		10	--	--
Total polychlorinated biphenyls (μg/kg dry weight)									
Polychlorinated biphenyls		320	860	640	980		130	--	2,500
TOC normalized PCBs (ppm/OC)[i]		16.0	35.8	23.7	42.8		--	38[g]	--
Volatile Organic Compounds (μg/kg dry)									
Trichloroethene		1.2 U	1.1 U	1.2 U	1.2 U		160	1,168	1,600
1,1,2,2-Tetrachloroethene		1.2 U	1.1 U	1.2 U	1.2 U		14	102	210
Ethylbenzene		1.2 U	1.1 U	1.2 U	1.2 U		10	27	50
ortho-Xylene		1.2 U	1.1 U	1.2 U	1.2 U		--	--	--
para- and meta-Xylene isomers		1.2 U	1.1 U	1.2 U	1.2 U		--	--	--
Total Xylenes		1.2 U	1.1 U	1.2 U	1.2 U		12	--	160
Butyltins (μg/kg dry)									
Monobutyltin		10 UJ	10 UJ	10 U	10 U		30	--	--
Dibutyltin		10 UJ	10 UJ	10 U	10 U		30	--	--
Tributyltin		10 UJ	10 UJ	19	10 U		30	--	--
Tetrabutyltin		10 UJ	10 UJ	10 U	10 U		30	--	--

Note -- – no PSDDA level has been established for these chemicals
BT – bioaccumulation trigger (exceedances indicated by shading)
DMMU – dredged material management unit
HPAH – high molecular weight polycyclic aromatic hydrocarbons
LPAH – low molecular weight polycyclic aromatic hydrocarbons
ML – maximum level (exceedances indicated by outline and shading)
PSDDA – Puget Sound Dredged Disposal Analysis program
SL – screening level (exceedances indicated by outline)

[a] Value represents the mean of the laboratory duplicate analyses for this sample.

[b] Value represents the mean of laboratory triplicate analyses for this sample.

[c] Total solids results are an average of all laboratory replicates from both Columbia Analytical Services Inc. and Analytical Resources Inc.

[d] Where SLs, BTs, and MLs in this table represent the sums of individual compounds (e.g., total LPAHs and total HPAHs) or groups of isomers (e.g., total PCBs), only the detected concentrations are used for calculating the sum of the respective compounds or groups of isomers. When all individual compounds or groups of isomers are undetected, the highest individual detection limit is reported.

[e] Total LPAH represents the sum of the concentrations of the following LPAH compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, and 2-methylnaphthalene. The total LPAH SLs, BTs, and MLs are not the sums of the corresponding SLs, BTs, and MLs listed for the individual LPAH compounds.

[f] Total HPAH represents the sum of the concentrations of the following HPAH compounds: fluoranthene, pyrene, benz[a]anthracene, chrysene, total benzofluoranthenes, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, and benzo[g,h,i]perylene. The total HPAH SLs, BTs, and MLs are not the sums of the corresponding SLs, BTs, and MLs listed for the individual HPAH compounds.

Total benzofluoranthenes represents the sum of the concentrations of the b and k isomers of benzofluoranthene.

[h] Total DDT represents the sum of 4,4'-DDD, DDE, and DDT.

[i] Total PCBs BT value in ppm carbon-normalized.

TABLE 2. MORTALITY OF AMPHIPODS, *RHEPOXYNIUS ABRONIUS*, IN SEDIMENT TOXICITY TESTS

Sample ID/ Replicate	Number of Dead Amphipods	Percent Mortality[a]	Statistically Significant?[b] (Probability)
Yaquina Bay Control Sediment			
1	0	0	
2	1	5	
3	3	15	
4	0	0	
5	0	0	
	Mean ± SD	4.0 ± 6.5	--
Carr Inlet Reference Sediment (CMS4-4)			
1	5	25	
2	2	10	
3	3	15	
4	4	20	
5	1	5	
	Mean ± SD	15.0 ± 7.9	--
DMMU1 (CMS4-5)			
1	2	10	
2	8	40	
3	8	40	
4	5	25	
5	2	10	
	Mean ± SD	25.0 ± 15.0	No (P=0.12)
DMMU2 (CMS4-1)			
1	7	35	
2	3	15	
3	6	30	
4	8	40	
5	5	25	
	Mean ± SD	29.0 ± 9.6	Yes (P=0.018)
DMMU3 (CMS4-2)			
1	8	40	
2	8	40	
3	11	55	
4	13	65	
5	8	40	
	Mean ± SD	48.0 ± 11.5	Yes (P=0.0006)
DMMU4 (CMS4-3)			
1	10	50	
2	13	65	
3	8	40	
4	6	30	
5	13	65	
	Mean ± SD	50.0 ± 15.4	Yes (P=0.002)

Note: DMMU - dredged material management unit
SD - standard deviation

[a] Based on an initial number of 20 amphipods in each replicate test chamber.

[b] Based on a one-tailed t-test of the difference between the mean mortality of the amphipods exposed to the test sediment and the mean mortality of the amphipods exposed to the reference sediment.

TABLE 3. ABNORMALITY AND MORTALITY OF SAND DOLLAR, *DENDRASTER EXCENTRICUS*, EMBRYOS IN SEDIMENT TOXICITY TESTS

Sample ID/ Replicate	Larvae Counted			Percent Abnormal/ Dead[a]	Statistically Significant?[b] (Probability)
	Normal	Abnormal	Total		
Seawater Control					
1	196	5	201	15.5	
2	250	4	254	-7.8	
3	222	4	226	4.3	
4	233	4	237	-0.4	
5	235	6	241	-1.3	
			Mean ± SD	2.1 ± 8.7	--
Carr Inlet Reference Sediment (CMS4-4)					
1	198	2	200	14.7	
2	138	4	142	40.5	
3	152	3	155	34.5	
4	189	3	192	18.5	
5	183	0	183	21.1	
			Mean ± SD	25.9 ± 11.1	--
DMMU1 (CMS4-5)					
1	136	7	143	41.4	
2	187	7	194	19.4	
3	186	12	198	19.8	
4	190	5	195	18.1	
5	169	23	192	27.2	
			Mean ± SD	25.2 ± 9.7	No ($P=0.46$)
DMMU2 (CMS4-1)					
1	183	20	203	21.1	
2	141	18	159	39.2	
3	176	5	181	24.1	
4	139	14	153	40.1	
5	199	5	204	14.2	
			Mean ± SD	27.7 ± 11.5	No ($P=0.40$)
DMMU3 (CMS4-2)					
1	207	3	210	10.8	
2	210	6	216	9.5	
3	185	1	186	20.3	
4	218	3	221	6.0	
5	181	9	190	22.0	
			Mean ± SD	13.7 ± 7.0	Yes ($P=0.04$)[c]
DMMU4 (CMS4-3)					
1	177	10	187	23.7	
2	184	7	191	20.7	
3	172	15	187	25.9	
4	214	6	220	7.8	
5	189	7	196	18.5	
			Mean ± SD	19.3 ± 7.0	No ($P=0.15$)

Note: DMMU - dredged material management unit
SD - standard deviation

[a] Based on an average initial count of 232 embryos per 10 mL subsample. Negative values reflect the fact that the initial count in individual replicates may have been greater than the average initial count.

[b] Based on a one-tailed *t*-test of the difference between the mean abnormality/mortality of the embryos exposed to the test sediment and the mean abnormality/mortality of the embryos exposed to the reference sediment.

[c] Although the difference was statistically significant, the mean abnormality/mortality of the embryos exposed to the test sediment was lower than the mean abnormality/mortality of the embryos exposed to the reference sediment.

TABLE 4. MORTALITY OF POLYCHAETES, *NEANTHES* sp., IN SEDIMENT TOXICITY TESTS

Sample ID/ Replicate	Number of Dead Polychaetes	Percent Mortality[a]	Statistically Significant?[b]
Yaquina Bay Control Sediment			
1	0	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	
	Mean ± SD	0 ± 0	--
Carr Inlet Reference Sediment (CMS4-4)			
1	0	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	
	Mean ± SD	0 ± 0	--
DMMU1 (CMS4-5)			
1	0	0	
2	1	20	
3	0	0	
4	0	0	
5	0	0	
	Mean ± SD	4 ± 8.9	No
DMMU2 (CMS4-1)			
1	0	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	
	Mean ± SD	0 ± 0	No
DMMU3 (CMS4-2)			
1	0	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	
	Mean ± SD	0 ± 0	No
DMMU4 (CMS4-3)			
1	0	0	
2	0	0	
3	0	0	
4	0	0	
5	0	0	
	Mean ± SD	0 ± 0	No

Note: DMMU - dredged material management unit
SD - standard deviation

[a] Based on an initial number of 5 polychaetes in each replicate test chamber.

[b] Statistical analyses were not performed because of zero variance in the reference sediment and three of the four test sediments. There are clearly no significant differences among these treatments.

TABLE 5. GROWTH RATE OF POLYCHAETES, *NEANTHES* sp., IN SEDIMENT TOXICITY TESTS

Sample ID/ Replicate	Total Biomass (mg)	Average Biomass Per Individual[a] (mg)	Individual Growth Rate[b] (mg/individ.-day)	Statistically Significant?[c] (Probability)
Yaquina Bay Control Sediment				
1	112.7	22.5	1.10	
2	93.0	18.6	0.90	
3	96.3	19.3	0.93	
4	89.7	17.9	0.87	
5	70.8	14.1	0.68	
		Mean ± SD	0.90 ± 0.15	--
Carr Inlet Reference Sediment (CMS4-4)				
1	69.4	13.9	0.66	
2	78.1	15.6	0.75	
3	114.0	22.8	1.11	
4	91.4	18.3	0.88	
5	72.0	14.4	0.69	
		Mean ± SD	0.82 ± 0.18	--
DMMU1 (CMS4-5)				
1	92.2	18.4	0.89	
2	67.7	16.9	0.82	
3	78.5	15.7	0.75	
4	92.2	18.4	0.89	
5	86.4	17.3	0.83	
		Mean ± SD	0.84 ± 0.06	No (P=0.42)
DMMU2 (CMS4-1)				
1	81.4	16.3	0.78	
2	86.1	17.2	0.83	
3	88.4	17.7	0.85	
4	71.9	14.4	0.69	
5	64.2	12.8	0.61	
		Mean ± SD	0.75 ± 0.10	No (P=0.25)
DMMU3 (CMS4-2)				
1	83.6	16.7	0.81	
2	80.4	16.1	0.77	
3	93.8	18.8	0.91	
4	72.1	14.4	0.69	
5	107.5	21.5	1.05	
		Mean ± SD	0.85 ± 0.14	No (P=0.40)
DMMU4 (CMS4-3)				
1	81.3	16.3	0.78	
2	45.1	9.0	0.42	
3	91.3	18.3	0.88	
4	91.8	18.4	0.89	
5	78.1	15.6	0.75	
		Mean ± SD	0.75 ± 0.19	No (P=0.27)

Note: DMMU - dredged material management unit
SD - standard deviation

[a] Based on the number of surviving polychaetes in each replicate chamber at test termination.

[b] Based on dividing the average increase in biomass per individual (relative to the average initial biomass per individual, 0.598 mg) by the total exposure time.

[c] Based on a one-tailed t-test of the difference between the mean individual growth rate of the polychaetes exposed to the test sediment and the mean individual growth rate of the polychaetes exposed to the reference sediment.

TABLE 6. COMPARISON OF SEDIMENT TOXICITY TEST RESULTS WITH PSDDA EVALUATION GUIDELINES FOR A NONDISPERSIVE DISPOSAL SITE

Test/Endpoint — Station(s): / Sample Number:	DMMU1 1/2 CMS4-5	DMMU2 3/4 CMS4-1	DMMU3 5/6 CMS4-2	DMMU4 7/8 CMS4-3	Carr Inlet Reference CMS4-4	Negative Control
Amphipod						
Mortality	25%	29%	48%	50%	15%	4%
(Mean Test − Mean Control) > 20% (2-hit rule)	21%	25%	44%	46%		
(Mean Test − Mean Reference) > 30% (1-hit rule)	10%	14%	33%	35%		
Significant Difference (P<0.05)	No	Yes	Yes	Yes		
Reference Sediment Performance Standard						
(Mean Reference − Mean Control) ≤ 20%					11%	
Negative Control Performance Standard						
(Mean Control) ≤ 10%						4%
Echinoderm						
# Normal	868	838	1,001	936	860	1,136
Percent abnormal/dead	25.2%	27.7%	13.7%	19.3%	25.9%	
(# Normal Test / # Normal Control) < 0.80 (2-hit rule)	0.76	0.74	0.88	0.82		
(# Normal Reference / # Normal Control) − (# Normal Test / # Normal Control) > 0.30 (1-hit rule)	−0.01	0.02	−0.12	−0.07		
Significant Difference (P<0.10)	No	No	Yes	No		
Reference Sediment Performance Standard						
(# Normal Reference / # Normal Control) ≥ 0.65					0.76	
Negative Control Performance Standard						
(# Normal Control / # Initial) ≥ 0.70						0.98

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TABLE 6. (cont.)

Test/Endpoint	DMMU1 1/2 CMS4-5	DMMU2 3/4 CMS4-1	DMMU3 5/6 CMS4-2	DMMU4 7/8 CMS4-3	Carr Inlet Reference CMS4-4	Negative Control
Station(s): / Sample Number:						
Neanthes						
Mortality	4%	0%	0%	0%	0%	0%
(Mean Test − Mean Control) > 20% (2-hit rule)	4%	0%	0%	0%		
(Mean Test − Mean Reference) > 30% (1-hit rule)	4%	0%	0%	0%		
Significant Difference ($P<0.05$)	No	No	No	No		
Reference Sediment Performance Standard						
(Mortality Reference − Mortality Control) ≤ 20%					0%	
Negative Control Performance Standard						
(Mortality Control) ≤ 10%						0%
Neanthes						
Growth (mg/individual-day)	0.84	0.75	0.85	0.75	0.82	0.90
(Mean Individual Growth Test / Mean Individual Growth Control) < 0.80 (2-hit rule)	0.93	0.83	0.94	0.83		
(Mean Individual Growth Test / Mean Individual Growth Reference) < 0.50 (1-hit rule)	1.02	0.91	1.04	0.91		
Significant Difference ($P<0.05$)	No	No	No	No		
Reference Sediment Performance Standard						
(Mean Individual Growth Reference / Mean Individual Growth Control) ≥ 0.80					0.91	
Negative Control Performance Standard						
(Mortality Control) ≤ 10%						0%

Note: DMMU - dredged material management unit
PSDDA - Puget Sound Dredged Disposal Analysis

Boxed values indicate exceedance of the applicable nondispersive disposal site interpretation guideline. Such exceedances must also be accompanied by statistical significance to be considered a "hit."

TABLE 7. CHEMICAL RESULTS FOR THE SEDIMENTS COLLECTED FOR USE IN THE BIOACCUMULATION EXPOSURES

	DMMU1	Carr Inlet
Station(s):	1/2	Reference
Sample number:	S4BC-2	S4BC-1
Conventional variables		
Total volatile solids (%)	3.6	2.0
Total organic carbon (%)	1.9	0.50
Percent gravel	0.44	0.01
Percent sand	63.7	49.5
Percent silt	28.0	45.3
Percent clay	7.9	5.2
Total solids (%)	69.9	65.2
Polycyclic aromatic hydrocarbons (µg/kg dry weight)		
Naphthalene	6	NA [a]
Acenaphthylene	5	NA [a]
Acenaphthene	31	NA [a]
Fluorene	34	NA [a]
Phenanthrene	397	NA [a]
Anthracene	202	NA [a]
2-Methylnaphthalene	5 U	NA [a]
Fluoranthene	1600	NA [a]
Pyrene	1700	NA [a]
Benz(a)anthracene	990	NA [a]
Chrysene	1100	NA [a]
Total benzofluoranthenes [b]	1223	NA [a]
Benzo(a)pyrene	510	NA [a]
Indeno(1,2,3-cd)pyrene	404	NA [a]
Dibenz(a,h)anthracene	139	NA [a]
Benzo(g,h,i)perylene	287	NA [a]

[a] NA - not analyzed

[b] Total benzofluoranthenes represents the sum of the concentrations of the b and k isomers of benzofluoranthene.

TABLE 8. MACOMA AND NEPHTYS TISSUE PAH CONCENTRATIONS (µg/kg wet weight)

	Macoma														
	Time 0 Tissue Samples					Organisms Exposed to Reference Sediment					Organisms Exposed to DMMU1 Sediment				
	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5
Naphthalene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthylene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Fluorene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Phenanthrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	10	12	8	10	24
Anthracene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	8	5 U	6	6
Fluoranthene	6	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	61	92	52	64	73
Pyrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	333	470	260	302	269
Benz(a)anthracene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	33	47	26	30	38
Chrysene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6	5 U	5 U	62	88	48	56	58
Benzo(b)fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	51	88	50	53	58
Benzo(k)fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	24	27	28	28	31
Benzo(a)pyrene	5 U	5 U	5 U	5 U	6	6	5 U	9	5 U	6	34	53	42	38	45
Indeno(1,2,3-cd)pyrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibenz(a,h)anthracene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(g,h,i)perylene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

	Nephtys														
	Time 0 Tissue Samples					Organisms Exposed to Reference Sediment					Organisms Exposed to DMMU1 Sediment				
	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5
Naphthalene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthylene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acenaphthene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Fluorene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Phenanthrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	7	8	6	5	5 U
Anthracene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	48	33	35	5 U	24
Pyrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	410	290	320	310	220
Benz(a)anthracene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	11	8	6	8	5 U
Chrysene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	75	59	60	56	44
Benzo(b)fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	13	12	10	8	5 U
Benzo(k)fluoranthene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	9	6	5 U	5	5 U
Benzo(a)pyrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	7	6	5 U	5 U	5 U
Indeno(1,2,3-cd)pyrene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibenz(a,h)anthracene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzo(g,h,i)perylene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

TABLE 9. TOTAL SOLIDS CONTENT OF MACOMA AND NEPHYTS TISSUE SAMPLES

Tissue Sample	Replicate		Total Solids (%)
Macoma			
Reference	1		16.8
	2		16.6
	3		16.3
	4		17.1
	5		13.2
DMMU1	1		16.5
	2		16.2
	3		16.4
	4		16.3
	5		14.7
		Mean	16.0
Nephtys			
Reference	2		16.9
	3		17.1
		Mean	17.0

TABLE 10. MACOMA AND NEPHTYS TISSUE PAH CONCENTRATIONS (µg/kg dry weight)

	Macoma														
	Time 0 Tissue Samples					Organisms Exposed to Reference Sediment					Organisms Exposed to DMMU1 Sediment				
	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5
Naphthalene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	30 U	31 U	30 U	31 U	34 U
Acenaphthylene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	30 U	31 U	30 U	31 U	34 U
Acenaphthene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	30 U	31 U	30 U	31 U	34 U
Fluorene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	30 U	31 U	30 U	31 U	34 U
Phenanthrene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	61	74	49	61	160
Anthracene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	30 U	49	30 U	37	41
Fluoranthene	37	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	370	570	320	390	500
Pyrene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	2000	2900	1600	1900	1800
Benz(a)anthracene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	200	290	160	180	260
Chrysene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	37	29 U	38 U	380	540	290	340	390
Benzo(b)fluoranthene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	310	540	300	330	390
Benzo(k)fluoranthene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	150	170	170	170	210
Benzo(a)pyrene	31 U	31 U	31 U	31 U	37	36	30 U	55	29 U	45	210	330	260	230	310
Indeno(1,2,3-cd)pyrene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	30 U	31 U	30 U	31 U	34 U
Dibenz(a,h)anthracene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	30 U	31 U	30 U	31 U	34 U
Benzo(g,h,i)perylene	31 U	31 U	31 U	31 U	31 U	30 U	30 U	31 U	29 U	38 U	30 U	31 U	30 U	31 U	34 U

	Nephtys														
	Time 0 Tissue Samples					Organisms Exposed to Reference Sediment					Organisms Exposed to DMMU1 Sediment				
	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5
Naphthalene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U
Acenaphthylene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U
Acenaphthene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U
Fluorene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U
Phenanthrene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	41	47	35	29	29 U
Anthracene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U
Fluoranthene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	280	190	210	29 U	140
Pyrene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	2400	1700	1900	1800	1300
Benz(a)anthracene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	65	47	35	47	29 U
Chrysene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	440	350	350	330	260
Benzo(b)fluoranthene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	76	71	59	47	29 U
Benzo(k)fluoranthene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	53	35	29 U	29	29 U
Benzo(a)pyrene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	41	35	29 U	29 U	29 U
Indeno(1,2,3-cd)pyrene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U
Dibenz(a,h)anthracene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U
Benzo(g,h,i)perylene	29 U	29 U	29 U	29 U	29 U	29 U	30 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U	29 U

DAIS DATA CHECKLIST

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DAIS DATA CHECKLIST

(shaded areas indicate required data)

	Test Sediment	Reference Sediment	Control Sediment	Seawater Control
Sample Locations and Compositing				
Latitude and longitude (to nearest 0.1 sec)	1: 47°32'5.2"N 122°19'12.6"W 2: 47°32'4.5"N 122°19'11.5"W 3: 47°32'5.7"N 122°19'10.7"W 4: 47°32'6.1"N 122°19'10.1"W 5: 47°32'6.7"N 122°19'8.6"W 6: 47°32'7.1"N 122°19'8.6"W 7: 47°32'7.6"N 122°19'7.8"W 8: 47°32'8.3"N 122°19'6.7"W	47°19'59"N 122°40'34"W	NA	NA
NAD 1927 or 1983	NAD 1983	NA	NA	NA
USGS Benchmark ID	NA	NA	NA	NA
Station name (e.g., Carr Inlet)	Duwamish River, Slip 4	Carr Inlet	Yaquina Bay, OR	Yaquina Bay, OR
Water depth (corrected to MLLW)	1: -13.8 ft MLLW 2: -12.5 ft MLLW 3: -14.7 ft MLLW 4: -13.7 ft MLLW 5: -12.8 ft MLLW 6: -12.6 ft MLLW 7: -13.0 ft MLLW 8: -13.3 ft MLLW	-49 ft MLLW	NA	NA
Drawing showing sampling locations and ID numbers	(see attached Figure 1)	NA	NA	NA

Compositing scheme (sampling locations/depths for composites)	Sample CMS4-5 for DMMU 1: 1: -13.8 ft to -17.0 ft MLLW 2: -12.5 ft to -17.0 ft MLLW Sample CMS4-1 for DMMU 2: 3: -14.7 ft to -17.0 ft MLLW 4: -13.7 ft to -17.0 ft MLLW Sample CMS4-2 for DMMU 3: 5: -12.8 ft to -17.0 ft MLLW 6: -12.6 ft to -17.0 ft MLLW Sample CMS4-3 for DMMU 4: 7: -13.0 ft to -17.0 ft MLLW 8: -13.3 ft to -17.0 ft MLLW	NA	NA	NA
Sampling method	Impact corer	0.1-m² van Veen	NA	NA
Sampling dates	7/13/95	7/17/95	7/18/95	7/20/95
Estimated volume of dredged material represented by each DMMU	DMMU 1: 4,000 cubic yards DMMU 2: 3,000 cubic yards DMMU 3: 2,500 cubic yards DMMU 4: 2,500 cubic yards			
Positioning method	Lazer track	DGPS	NA	NA

Sediment Conventionals						
	TOC	TVS	Total Sulfides	Ammonia	Total Solids	Grain Size Distribution
Preparation and analysis methods	Method 5310B (modified)	EPA Method 160.4	PSEP	Plumb	EPA Method 160.3	PSEP
Sediment conventional data and QA/QC qualifiers	None assigned	None assigned	J	J	None assigned	None assigned
QA qualifier code definitions	Not applicable	Not applicable	Estimated	Estimated	Not applicable	Not Applicable
Triplicate data for each sediment conventional for each batch	Yes	Replicates	Replicate	Replicates	Replictes	Yes
Units (dry weight except total solids)	percent	percent	mg/kg	mg/kg	percent	percent
Method blank data (sulfides, ammonia, TOC)	TOC not detected	Not applicable	Total sulfides not detected	Ammonia not detected	Not applicable	Not applicable
Method blank units (dry weight)	percent	Not applicable	mg/kg	mg/kg	Not applicable	Not applicable
Analysis dates (sediment conventionals, blanks, TOC CRM)	07/21/95	07/19/95	07/20/95	07/24/95	07/21/95	07/19/95
TOC CRM ID	NBS 2704	--	--	--	--	--
TOC CRM analysis data	0.307 percent	--	--	--	--	--
TOC CRM target values	0.335 percent	--	--	--	--	--

Grain size analysis	
Fine grain analysis method	Pipet
Analysis dates	07/19/95
Triplicate for each batch	Yes
Grain size data (complete sieve and phi size distribution)	Yes

	Metals	Semivolatiles	Pesticides/ PCBs	Volatiles	Butyltins
Chemicals of Concern Analysis Data					
Extraction/digestion method	Strong acid digestion	Soxhlet	Soxhlet	Purge and Trap	Tumble
Extraction/digestion dates (test sediment, blanks, matrix spike, reference material)	07/24/95 and 07/26/95	07/21/95	07/21/95	07/21/95	07/24/95 and 08/03/95 (re-extractions)
Analysis method	GFAA and ICP	SW-846 Method 8270, as modified by PSEP	SW-846 Method 8080, as modified by PSEP	SW-846 Method 8260	Krone et al. (1989), with confirmation by GC/MS
Data and QA qualifier included for:	None required	Pentachlorophenol	None required	None required	All results for samples CMS 4-1 and CMS 4-5 qualified as estimated (*J*)
Test sediments	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Reference materials including 95 percent confidence interval (each batch)	NIST 1646a and NIST 2704[1]	SQ-1[1]	SQ-1[1]	Not applicable	None analyzed
Method blanks (each batch)	1 per batch	1 per batch	1 per batch	1 per batch	1 per batch
Matrix spikes (each batch)	1 per batch[1]	1 per batch[1]	1 per batch[1]	1 per batch[1]	1 per batch[1]
Matrix spike added (dry weight basis)	See attached data package	See attached data package	See attached data package	See attached data package	See attached data pakcage
Replicates (each batch)	1 per batch[1]	1 per batch[1]	1 per batch[1]	1 per batch[1]	1 per batch[1]
Units (dry weight)	mg/kg	µg/kg	µg/kg	µg/kg	µg/kg

	Metals	Semivolatiles	Pesticides/ PCBs	Volatiles	Butyltins
Chemicals of Concern Analysis Data (cont.)					
Method blank units (dry weight)	mg/kg	µg/kg	µg/kg	µg/kg	µg/kg
QA/QC qualifier definitions	*U* = undetected	*U* = undetected *J* = estimate	*U* = undetected	*U* = undetected	*U* = undetected *J* = estimated
Surrogate recovery for test sediment, blank, matrix spike, reference material	NA	Acceptable[1]	Acceptable[1]	Acceptable[1]	Acceptable[1]
Analysis dates (test sediment, blanks, matrix spike, reference material)	07/27/95	08/03/95	07/28/95, 07/29/95, and 07/31/95	07/21/95	07/30/95 and 08/10/95 (re-extractions)

[1] See data reporting forms in laboratory sample delivery groups for information

	Each Batch	Test Sediment	Reference Sediment	Control Sediment
Amphipod Mortality and Emergence				
Species name	*Rhepoxynius abronius*	*Rhepoxynius abronius*	*Rhepoxynius abronius*	*Rhepoxynius abronius*
Mortality and emergence:				
Start date	7/21/95	7/21/95	7/21/95	7/21/95
Daily emergence (for 10 days)	NA	1/2: 23 3/4: 29 5/6: 28 7/8: 30	15	4
Survival at end of test	NA	1/2: 75 3/4: 71 5/6: 52 7/8: 50	85	96
Number failing to rebury at end of test	NA	1/2: 9 3/4: 19 5/6: 10 7/8: 5	6	1
Positive control:				
Toxicant used	$CdCl_2$	NA	NA	NA
Toxicant concentrations	0.1 mg/L 0.3 mg/L 1 mg/L 3 mg/L 10 mg/L	NA	NA	NA
Exposure time	96 hour	NA	NA	NA
LC_{50}	0.40 mg/L Cd	NA	NA	NA
LC_{50} method of calculation	Probit transform	NA	NA	NA

	Each Batch	Test Sediment	Reference Sediment	Control Sediment
Start date	7/21/95	NA	NA	NA
Water quality measurement methods:				
Dissolved oxygen	NA	PSEP	PSEP	PSEP
Ammonia	NA	EPA Method 350.1	EPA Method 350.1	EPA Method 350.1
Interstitial salinity	NA	PSEP	PSEP	PSEP
Sulfide	NA	EPA Method 376.1	EPA Method 376.1	EPA Method 376.1
Water salinity	NA	PSEP	PSEP	PSEP
Water quality:				
Temperature (Day 0 through Day 10)	NA	15.6 ± 0.5	15.6 ± 0.5	15.6 ± 0.5
pH (Day 0 through Day 10)	NA	8.0 ± 0.2	8.0 ± 0.2	8.0 ± 0.2
Dissolved oxygen (Day 0 through Day 10)	NA	8.0 ± 0.1	8.0 ± 0.1	8.0 ± 0.1
Water salinity (Day 0 through Day 10)	NA	28.4 ± 0.8	28.4 ± 0.8	28.4 ± 0.8
Sulfide (Day 0, Day 10)	NA	<0.01	<0.01	<0.01
Ammonia (Day 0, Day 10)	NA	0.1-4.0	0.1-4.0	0.1-4.0
Interstitial water salinity (Day 0)	NA	28.0	28.0	28.0

	Each Batch	Test Sediment	Reference Sediment	Seawater Control
Sediment Larval Mortality and Abnormality				
Species name	*Dendraster excentricus*	*Dendraster excentricus*	*Dendraster excentricus*	*Dendraster excentricus*
Toxicity test parameters:				
Inoculation time (hrs)	NA	1.5 hrs	1.5 hrs	1.5 hrs
Exposure time (hrs)	NA	65 hrs	65 hrs	65 hrs
Stocking beaker density (No/mL)	NA	23.2/mL	23.2/mL	23.2/mL
Stocking aliquot size (mL)	NA	10 mL	10 mL	10 mL
Aeration (yes/no)	NA	yes	yes	yes
Mortality and abnormality:				
Start date	NA	7/21/95	7/21/95	7/21/95
Initial count (minimum of five 10-mL aliquots)	NA	232/ 10 mL	232/ 10 mL	232/ 10 mL
Final count:				
Aliquot size (mL)	NA	10 mL	10 mL	10 mL
Number normal per aliquot	NA	1/2: 226.2 ± 3.7 3/4: 224.9 ± 4.2 5/6: 229.8 ± 1.6 7/8: 227.3 ± 2.1	230.5 ± 1.1	230 ± 0.5
Number abnormal per aliquot	NA	1/2: 5.8 ± 3.7 3/4: 7.1 ± 4.2 5/6: 2.2 ± 1.6 7/8: 4.7 ± 2.1	1.5 ± 1.1	2.0 ± 0.5
Water quality measurement methods:				
Dissolved oxygen	NA	PSEP	PSEP	PSEP

	Each Batch	Test Sediment	Reference Sediment	Seawater Control
Ammonia	NA	EPA Method 350.1	EPA Method 350.1	EPA Method 350.1
Sulfide	NA	EPA Method 376.1	EPA Method 376.1	EPA Method 376.1
Water salinity	NA	PSEP	PSEP	PSEP
Water Quality:				
Temperature (daily)	NA	16.3 ± 0.4	16.3 ± 0.4	16.3 ± 0.4
pH (daily)	NA	7.9 ± 0.1	7.9 ± 0.1	7.9 ± 0.1
Dissolved oxygen (daily)	NA	8.0 ± 0.2	8.0 ± 0.2	8.0 ± 0.2
Water salinity (daily)	NA	28.0 ± 0.0	28.0 ± 0.0	28.0 ± 0.0
Sulfide (initial and final)	NA	<0.01	<0.01	<0.01
Ammonia (initial and final)	NA	<0.1-0.4	<0.1-0.4	<0.1-0.4
Positive Control:				
Toxicant used	$CdCl_2$	NA	NA	NA
Toxicant concentrations	0 mg/L 1 mg/L 2 mg/L 4 mg/L 8 mg/L 15 mg/L	NA	NA	NA
Exposure time	48 hrs	NA	NA	NA
EC_{50}	8.78 mg/L	NA	NA	NA
EC_{50} method of calculation	probit trans-form	NA	NA	NA
Start date	7/21/95	NA	NA	NA

Note:

CRM	-	certified reference material
DGPS	-	differential global positioning system
GC/MS	-	gas chromatography/mass spectrometry
DMMU	-	dredged material management unit
MLLW	-	mean lower low water
NA	-	not applicable
PCB	-	polychlorinated biphenyl
PSEP	-	Puget Sound Estuary Program protocols
QA/QC	-	quality assurance and quality control
TOC	-	total organic carbon

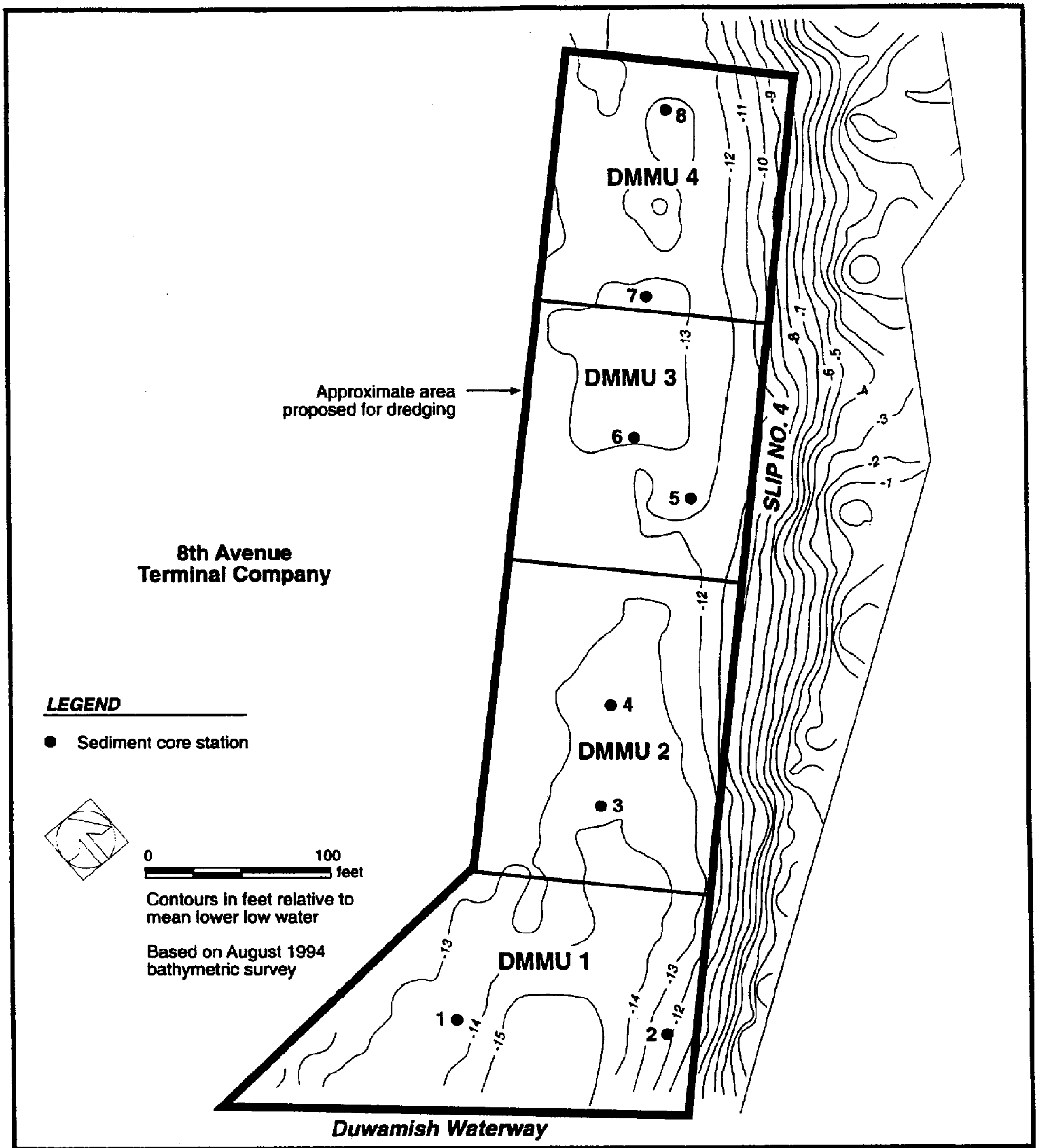

	Figure 1. Sediment core station locations. **Crowley Marine Services** **8th Avenue Terminal** **7400 8th Ave. S.** **Seattle, WA 98108**	**PROPOSED DREDGING** IN: Slip No. 4, Duwamish Waterway AT: Seattle COUNTY OF: King STATE: WA APPLICATION BY: Crowley Marine Services SHEET: DATE: 03/29/95

C483-06-02 03/07/96

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